CHAPTER 11

ORGANIC VAPOR MONITORING PROCEDURES

11-1. General. This chapter describes monitoring of organic vapors using a portable PID and FID in the UST work environment. Both PIDs and FIDs are useful as general survey instruments at UST sites. A PID is capable of detecting and measuring real-time concentrations of many organic vapors in the air. A PID is similar to a FID in application. Equipment calibration should be done at the frequency and in accordance with the written manufacturer's instructions. Table 11-1 describes the application comparisons between a PID and an FID. Other types of measuring devices such as colorimetric or immunoassay can be used, but they do not provide the continuous readout of the PID or FID instruments.

a. PID. A PID responds to most vapors that have an ionization potential less than or equal to that supplied by the ionizing ultraviolet (UV) lamp in the detector. Several lamps are available for the PID, each having a different source wave length and subsequent different ionization potential. For this reason, the selection of the appropriate lamp is essential in obtaining useful field results. Although it can be calibrated to a particular compound, the instrument cannot distinguish between detectable compounds in a mixture of gases. Therefore, it indicates an integrated response to the mixture.

b. FID. An FID is useful as a general screening tool to detect the presence of most organic vapors. It can detect pockets of gaseous hydrocarbons in depressions or confined spaces and can screen an area for the presence of elevated levels of vapor-phase organics. The FID will respond to most organic vapors as they form positively charged ions when burned in a hydrogen flame. The magnitude of the response is a function of the detector sensitivity and the ionization properties and concentration of the particular compound. As a result, the response must be compared with the response generated by a known concentration of a standard gas. The sample concentration is then reported as the ppm-equivalent of the standard gas. Most units are calibrated with methane; however, almost any gaseous hydrocarbon that produces a response can be used. Many models also have built-in calibration circuits to ensure that the electronic response remains constant in all ranges.

11-2. Precautions. Personnel involved in the procedures outlined in this chapter should be familiar with the potential hazards and know in the appropriate safety and health measures needed to ensure a safe working environment. During the course of UST activities, workers may be exposed to petroleum hydrocarbon liquids and vapors and other hazardous wastes. Good safety practices should be observed by all individuals using this procedure.

TABLE 11-1
COMPARISON OF THE FID AND PID

	FID	PID
Response	Responds to many organic gases and vapors, especially low molecular weight hydrocarbons.	Responds to many organic and some inorganic gases and vapors, especially heavy hydrocarbons.
Application	In survey mode, detects total concentrations of gases and vapors. In GC mode, identifies compounds.	In survey mode, detects total concentrations of gases and vapors. Some compounds possible if GC column and standards are used.
Limitations	Does not respond to inorganic gases and vapors with a higher ionization potential than the flame detector. No temperature control.	Does not respond to methane or inorganic aliphatic chlorinated solvents. Does not respond properly in presence of water vapor (high humidity). Does not detect a compound if probe (lamp) has a lower energy than compound's ionization potential.
Calibration Gas	Methane and others.	Benzene (1,3-butadiene) and others.
Ease of Operation	Requires experience to interpret correctly, especially in GC mode.	Fairly easy to use and interpret. More difficult in the GC mode.
Detection Limits	0.1 ppm (methane).	0.1 ppm (benzene), depends on lamp voltage.
Response Time	2-3 sec (survey mode).	3 sec for 90 percent of total concentration.
Maintenance	Periodically clean and inspect particle filters, valve rings, and burner chamber. Check calibration and pumping system for leaks. Recharge battery after each use.	Clean UV lamp frequently. Check calibration regularly. Recharge battery after each use.
Useful Range	0-1,000 ppm.	0-2,000 ppm.
Service Life	8 hours; 3 hours with strip-chart recorder.	10 hours; 5 hours with strip-chart recorder.

Monitor potentially toxic or potentially explosive vapors to determine when an explosive or toxic hazard exists in the work environment.

11-3. PID Operations, Procedures, and Instructions. Site personnel responsible for organic vapor monitoring should be familiar with all safety rules and regulations and the procedures for operating equipment.

a. Limitations.

(1) The PID is a nonspecific total vapor detector. It cannot be used to identify substances; it can only quantify substances.

(2) The PID must be calibrated to a specific compound.

(3) The PID does not respond to certain low molecular weight hydrocarbons such as methane and ethane.

(4) Certain models of PID instruments are not intrinsically safe. Refer to the manufacturer's operating manual for use in potentially flammable or combustible atmospheres.

(5) A PID should be used in conjunction with a CGI.

(6) Electrical power lines or power transformers close to the PID instrument may cause measurement errors. Under these circumstances, refer to the operating manual for proper procedures.

(7) High winds and high humidity will affect measurement readings. Certain models of PID instruments become unusable under foggy or high humidity conditions.

(8) The lamp must be periodically cleaned to ensure ionization of the air contaminants.

(9) Consult the manufacturer's operating manual to determine the instrument's response to various chemicals.

b. Calibration. Transport of calibration gas cylinders by passenger and cargo aircraft is guided by the U. S. Code of Federal Regulations, 49 CFR Parts 100-177. Benzene is a typical calibration gas included with a PID. Benzene is classified as a nonflammable gas, UN1556, and the proper shipping name is "compressed gas." It must be shipped in cargo aircraft only.

c. Instrument Preparation. Assemble the PID equipment and supplies listed in Table 11-2. Perform the startup procedures and operational checks described below.

(1) Assemble the instrument and check battery according to manufacturer's instructions. Turn on the PID.

(2) Zero the instrument using zero-calibration air or ambient air.

(3) Calibrate the instrument according to the manufacturer's specifications. At a minimum, instruments should be calibrated daily at field conditions.

(4) Contact the carrier that will transport equipment and hazardous materials to obtain information on regulations and specifications.

TABLE 11-2
PHOTOIONIZATION DETECTOR (PID)
EQUIPMENT AND SUPPLIES CHECKLIST

	Photoionization Detector (PID)
	Operating Manual
	Probes: 9.5eV_____, 10.2eV_____, and 11.7eV_____
	Battery Charger for PID
	Spare Batteries
	Jeweler's Screwdriver for Adjustments
	Tygon Tubing
	NIST Traceable Calibration Gas (type: _____)
	"T" Valve for Calibration
	Intake Assembly Extension
	Strap for Carrying PID
	Teflon Tubing for Downhole Measurements
	Plastic Bags for Protecting the PID from Moisture and Dirt

d. Documentation Preparation.

(1) Obtain a logbook.

(2) Record results of the equipment check in the logbook.

e. Field Preparation.

(1) Follow the startup procedures and operational check as described in Section 11.3. Check the calibration of the instrument against a known sample of calibration gas. If the calibration is outside manufacturer's specifications, recalibrate the instrument.

(2) Follow the instructions in the operating manual explicitly to obtain accurate results. As with any field instrument, accurate results depend on the operator's knowledge of the manual.

(3) Position the PID intake assembly close to the monitoring area because the low sampling rate allows for only very localized readings. Do not immerse the intake assembly in fluid under any circumstances.

(4) Monitor the work activity as specified in the SSHP while taking care not to permit the PID to be exposed to excessive moisture, dirt, or contamination. Conduct the PID survey at a slow-to-moderate rate of speed and slowly sweep the intake assembly (the probe) from side to side.

(5) Evacuate the area if the preset alarm sounds. Operators using supplied air systems may not need to evacuate the work area, but they should frequently observe the levels indicated by the instrument.

(6) Static voltage sources like power lines, radio transmissions, or transformers may interfere with measurements. See the operator's manual for a discussion of necessary considerations.

f. Post Operation.

(1) Field.

(a) Carefully clean the outside of the PID with a damp disposable towel to remove any visible dirt when the

activity is completed or at the end of the day. Return the PID to a secure area and place on charge.

(b) Ensure that all equipment is accounted for and decontaminated.

(2) Documentation.

(a) Record any uncompleted work (such as additional monitoring) in the logbook.

(b) Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

(c) Review data collection forms for completeness.

(3) Office.

(a) Deliver original forms and logbooks to the document control officer with copies to the project manager and files.

(b) Inventory equipment and supplies. Repair or replace all broken or damaged equipment and charge the batteries. Replace expendable items. Return equipment and report incidents of malfunction or damage. If necessary, replenish supplies of the NBS traceable calibration gas.

11-4. FID Operations, Procedures, and Instructions. Site personnel should be familiar with all safety rules and regulations and procedures for operating equipment.

a. Limitations.

(1) The FID does not respond to nongaseous organic compounds such as some pesticides, polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

(2) Most portable FIDs use the sample gas as combustion air for the detector flame and are designed to operate in ambient atmospheres with oxygen concentrations of approximately 21 percent. This design precludes the sampling of process vents, poorly ventilated or sealed containers, or any sample gas with a hydrocarbon concentration sufficient to reduce the available oxygen or saturate the detector. Optional equipment is available to supply oxygen from a compressed gas cylinder or

introduce sample gas through a dilution system with a known dilution factor.

(3) Concentrations beyond the greatest scale factor of the instrument or in excess of 30 percent of the LEL of the sample component require system modification. If system modifications are required, consult the manufacturer's operating manual.

b. Calibration. FID instruments usually have a negligible response to carbon monoxide (CO) and carbon dioxide (CO_2). Their structures preclude the production of appreciable ions in the detector flame so other organic materials may be analyzed in the presence of CO; and, as with the PID, the FID responds differently to different compounds. Because the instrument is factory-calibrated to methane, all relative responses are given in percentages with methane at 100. Therefore, the identity of the chemical of interest must be ascertained before its concentration can be determined.

In addition, the FID unit requires a trained individual to maintain and operate the unit. Department of Transportation regulations prohibit the carrying of compressed hydrogen gas on passenger aircraft. When the FID instrument is transported on a passenger aircraft, the hydrogen gas contained in the instrument must be emptied before loading. Transport of an FID or extra cylinders of hydrogen gas or calibration gas by cargo aircraft must comply with the regulations stipulated in 49 CFR Parts 100-177. Consult the shipper for any recent changes in this procedure.

c. Instrument Preparation. Assemble the equipment and supplies listed in Table 11-3. Perform the startup procedures and functional checks described below. The purpose of these checks is to verify that an instrument will function properly (for example, the batteries are serviceable, and the instrument can be zeroed and calibrated) in the field. If problems develop, obtain a replacement unit and perform the same functional checks.

(1) Turn the instrument on and allow adequate warmup time.

(2) Check the battery charge level indicator. If it is not fully charged, recharge the battery as described in the manual.

(3) Turn on the pump and check for leaks by covering the sample inlet and observing the rotameter. The indicator ball should drop to zero.

(4) With the pump operating, open the hydrogen gas storage tank valve and the supply regulator to allow fuel gas to flow into the detector chamber.

(5) Depress the igniter switch, observe the indicator needle for positive response, and listen for a pop. If the flame fails to light, depress the igniter switch again. Once the detector flame is lit, the unit is ready for use. Before lighting the detector flame, always be sure that the combustion gas flow (usually sample gas) is started. If the detector fails to light, check over the instrument battery and gas levels and start again at Step 1. If the instrument still does not light, contact the project manager.

TABLE 11-3
FLAME IONIZATION DETECTOR (FID)
EQUIPMENT AND SUPPLIES CHECKLIST

	Flame Ionization Detector (FID)
	Probe Extension
	Operating Manual
	Battery Charger
	Spare Batteries
	Jeweler's Screwdriver for Adjustments and Calibration
	Refueling Hose for Hydrogen Cylinder
	NIST Traceable Calibration Gas (type: _____)

(6) If the instrument has internal calibration capability, perform the instrument calibration according to the procedures described in the operating manual.

d. Documentation Preparation.

(1) Obtain a logbook.

(2) Record equipment checking results in the field logbook.

(3) Obtain a sufficient number of the appropriate data collection forms.

e. Field Preparation. Before using the FID in the field, perform the following instrument checks to ensure that the equipment was not damaged during transport.

(1) Follow the instrument checkout procedures described above in office preparation.

(2) If calibration to a specific hydrocarbon species is desired, complete this procedure according to the manufacturer's operating instructions.

(3) Calibrate the FID daily before each use in the field.

(4) Hold the sample probe in the area in question. The low sample rate allows for only very localized readings.

(5) A slow sweeping motion should help prevent the bypassing of problem areas. Make sure the batteries are recharged within the time frame specified in the operator's manual. The usual length of operating time between charges is 8 to 12 hours.

(6) Perform FID monitoring at 1.5-meter (5-foot) intervals downhole, at the headspace, and in the breathing zone during drilling activities. In addition, where elevated organic vapor levels are encountered, monitoring may be performed in the breathing zone during actual drilling. When the activity does not require drilling (like surface sampling), only record readings in the breathing zone. Consult the SSHP for the specific monitoring instructions.

(7) Check for an alarm on the unit that signals the operator if the detector flame goes out. If the alarm sounds, evacuate the work area, relight the flame in a known safe area, and reenter the site.

(8) Monitor fuel and combustion air supply gauges regularly to ensure sufficient gas supplies.

(9) Clean sample probe or in-line filters (in front of the detector), when high background readings occur or after prolonged use. Use pipe cleaners to clean the probe and apply clean air blown backwards through the probe to clean the filters. Do not use organic solvents because the detector may become saturated by the solvent.

(10) Perform the routine maintenance described in the operating manual. Because the FID unit contains pressurized gas supplies, leak-check procedures must be regularly performed. Leaking hydrogen gas is explosive.

(11) Modify the system if concentrations beyond the maximum full-scale capability of the instrument or in excess of 30-percent LEL of the sample component occur. Similar modification may be necessary for sampling in oxygen-deficient atmospheres. This usually entails increasing the combustion air to the detector by sample dilution or by an independent air supply. A dilution system apparatus is required to supply a filtered, controlled air supply for analyzers that use the sample gas stream as the source of combustion air. A dilution system can dilute a gas stream by ratios up to 100:1 through the selection of various critical orifices.

f. Post Operations. See paragraph 11-3f. The same post-operations process applies to both FIDs and PIDs.